



OFFICE OF NAVAL RESEARCH GLOBAL

2016 ANNUAL REPORT



Rear Adm. Hahn
Chief of Naval Research

In an interconnected world, where knowledge has no borders, ONR Global is essential to our mission of delivering decisive new capabilities to naval forces. Forging partnerships around the world brings invaluable insights to our research efforts, and maximizes resources by leveraging ongoing programs in partner nations. Working with fleet and force leadership at sea and in the field helps better define warfighter requirements—and that results in new capabilities for our men and women in uniform. I am grateful for the vital work being done by ONR Global. Press!



Capt. Clark Troyer
Commanding Officer, ONR Global

This report highlights some of the many ONR Global efforts in 2016 that directly support ONR's ability to discover, develop and deliver decisive technology to Sailors and Marines. Much was accomplished on all fronts – accelerating the delivery of technology to fill warfighter needs, expanding opportunities with international researchers, and deepening and expanding critical S&T partnerships. It must be stated that this only happens through exceptional collective efforts put forth across the command and in collaboration with experts in ONR, NRL and throughout the Naval Research and Development Establishment. In this age of acceleration, when technology is advancing at light speed and adversaries are working hard to achieve a technological edge, we must continue to break down barriers internally and externally to be successful.

Every command member should be extremely proud of their dedicated work and achievements in 2016, and encouraged by the opportunities we have encountered in 2017. As we look continue to support the priorities of the Chief of Naval Operations and the Chief of Naval Research, the command is expanding our footprint and technical competencies, and improving tools and business processes to cultivate the agility required to excel in this dynamic environment.

Well done!

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INTRODUCTION

The Office of Naval Research (ONR) Global acts as a two-way bridge from the U.S. naval fleet and U.S. Marine Corps Forces, the Office of the Chief of Naval Operations (OPNAV), the international science and technology (S&T) community, and foreign military partners to ONR to the Naval Research Enterprise (NRE) and other Department of Defense (DoD) and government agencies. From basic research to technology transition, ONR Global supports the Department of the Navy's (DoN) full spectrum of Research, Development, Test and Evaluation (RDT&E) through its Science Advisor, International Science, and International Liaison Offices. ONR Global advances the discovery and delivery elements of ONR's mission.



ONR GLOBAL MISSION STATEMENT

To serve as the preeminent external network facilitator for ONR and the greater NRE by ensuring quality/relevant connections between the international S&T community, naval fleet/force, and NRE regarding both current execution and developing long-range strategic efforts. To remain always focused on the current and future needs of our Sailors, Marines, naval service and international partners.

Four Strategic Principles

- Be forward deployed
- Maintain a high quality staff that is accomplished and cognitively diverse
- Foster a culture of communication and networking
- Portfolio approach to investments and engagements

Discover the Best Science

- Innovative basic research and scientists
- Shape future naval investments and strategies
- Leveraging great minds/global R&D investment
- Support Sailors & Marines today and tomorrow

Maintain Global Technical Awareness

- Prevent technological surprise
- Fundamental research is most transparent
- Contribute open-source data to global technology awareness

Science and Technology Partnerships and Collaborations

- Advance mutually beneficial science
- Supports theater security cooperation goals/LOE Purple
- Relevance to USN/USMC programs is key factor

ONR GLOBAL OVERVIEW

FOCUSING ON SCIENCE AND TECHNOLOGY AROUND THE WORLD



Rear Adm. Mat Winter, center, met with ONR Global staff in Singapore.

Science Advisor Program

Our Science Advisors are scientists and engineers who help introduce technology solutions to the Fleet/Forces. They are assigned to Navy and Marine Corps commands worldwide to:

- Serve as a command's senior liaison with S&T organizations in government, academia and industry
- Communicate needs and requirements back to the ONR and Naval Research Enterprise
- Facilitate rapid technology insertions and shape future S&T investments

International Science Program

Our Science Directors engage foreign academic institutions and industries to enhance or develop new opportunities for cooperative research. They use liaison visits and grants to:

- Discover the best science and engage global S&T talent guided by the Naval S&T Strategy
- Contribute open source data to Global Technology Awareness
- Build productive S&T relationships and link international researchers to the Naval Research Enterprise

International Liaison Office

Our International Program Officers develop and advance critical US Navy military to military international Science and Technology partnerships to

- Coordinate interactions and facilitate opportunities for S&T collaboration with foreign military R&D organizations
- Leverage ONR and ONRG resources to define mutually beneficial mil-mil cooperative projects
- Support CNR contribution to a well-coordinated US Navy theater security cooperation strategy

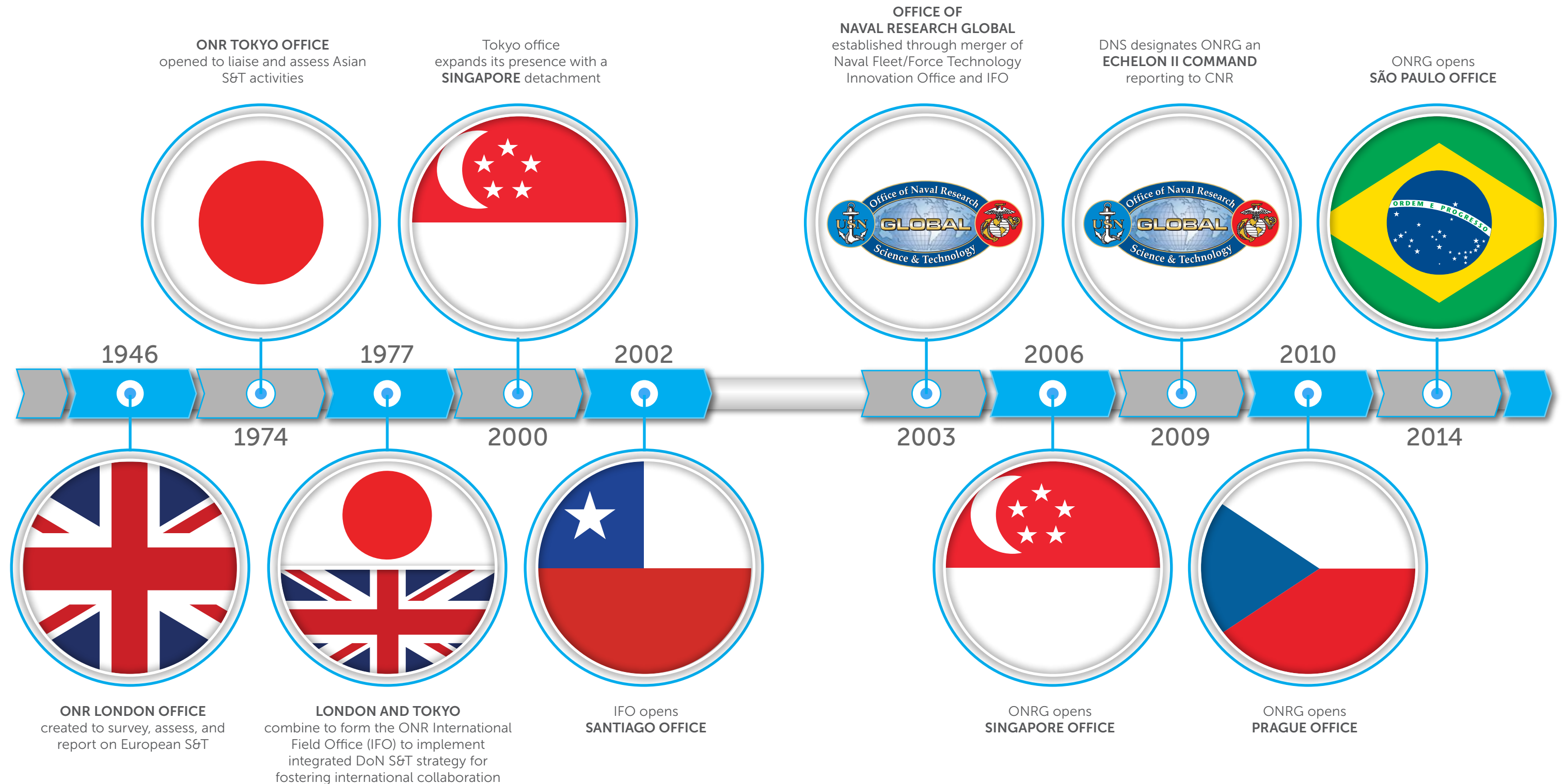


The U.S. representatives for the UK's Unmanned Warrior 2016 exercise attend the main planning conference at the QinetiQ Haslar facility near Portsmouth, England. Unmanned Warrior demonstrated the latest unmanned system technologies, including air, surface and sub-surface vehicles and sensors as part of Joint Warrior 16-2.

From Left to Right: Dr. Marcus Tepaske, USFFC Science Advisor, CAPT Beth Creighton, LT Chelsea Ware, CDR Santiago Carrizosa, and LCDR Brendan Gotowka, ONR Reserve Component, and Mr. Chris Marchefsky, C6F Science Advisor.

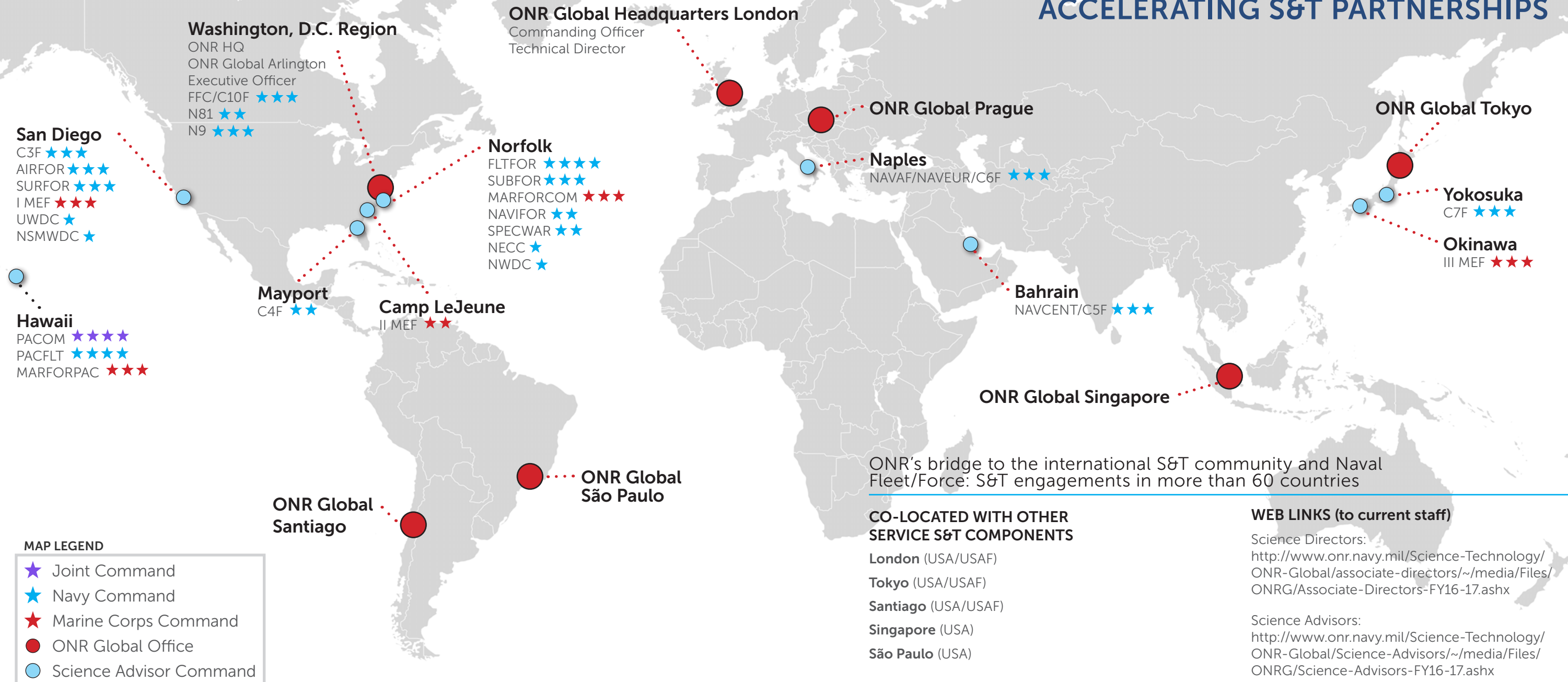
HISTORY

ONR GLOBAL



ONR'S GLOBAL NETWORK

ACCELERATING S&T PARTNERSHIPS





**U.S. NAVAL
FLEET AND FORCE**

60MM MORTAR DIRECT LAY LASER (DLL)



60mm Mortar with Direct Lay Laser at the Crow Valley Live Fire Range in the Republic of the Philippines in April 2016

The Marine Corps Forces Pacific (MARFORPAC) science advisor worked with ONR TechSolutions to incorporate an experiment in the Balikatan 2016 exercise, an annual military exercise in the Philippines between the U.S. and Philippine militaries. The experimental system was a direct lay laser (DLL) for a 60mm mortar. The DLL is a lightweight infrared pointer/illuminator that directs the mortar azimuth during nighttime direct-lay engagements.

The experiment was conducted at the Crow Valley Live Fire Range with six mortar men from 2nd Battalion, 2nd Marines (2/2 Marines). The nighttime live-fire events gave the 2/2 Marines the opportunity to train with the latest optics being developed for mortars, and provided developers with valuable technical data to improve future system performance.

Back-Up Information to 60mm Mortar Direct Lay Laser

Impact: This system allows infantry Marines to engage targets under low-light conditions with increased first-round accuracy as well as improved accuracy throughout the entire engagement.

April 1-9 Philippines ISO Balikatan 2016

Working with Rick Sams from ONR Tech Solutions, Franz Ravelo, MARFORPAC deputy science advisor, and I embedded with 2/2 Marines to perform a live-fire test and evaluation of the 60mm mortar sight. Our trip started at the forward operating base (FOB) at the base of Crow Valley, Philippines. The weapons platoon Marines provided transport and personal protective equipment (PPE) to move to the firing location further up the valley.



Marine Infantry Officer familiarizes himself with mounting the laser on the mortar sight at the Dining Facility (DFAC), FOB Crow Valley.



Franz Ravelo MARFORPAC Deputy Science Advisor receives safety briefing from III MEF Marines.



Franz Ravelo (Left) and Rick Sams (Right) with proper safety gear preparing for transport to firing position.



Traveling up Crow Valley in HUMVEE's to mortar firing position

Rick Sams led the training sessions with the weapons platoon Marines to familiarize themselves with the new technology. Using hands-on instruction, he demonstrated how to properly boresight and employ the laser sight for maximum effectiveness. Once the laser sight was properly boresighted in conjunction with the mortar sight, it reduced the time needed to effectively engage targets in low-light conditions and gave positive feedback to the mortar crew on how accurate the rounds were. This system increased the overall accuracy of the 60mm mortar fire, while decreasing the time needed to engage and adjust for targeting errors, especially in low-light conditions.



Rick Sams from ONR Tech Solutions 60mm Laser Sight with 2/2 Weapons Platoon Marines., Crow Valley Luzon, PI.

After the daytime training session, there was a follow-on night employment of the system in tactical conditions such as live-fire demonstrations. This was part of a larger combined weapons exercise in which coordinated fire from an M777-155mm artillery battery, an 82mm Mortar battery, an HMLA section (1 Huey/ 1 Cobra) and our 60mm battery was aimed at designated targets in the impact zone. More than 150 rounds of 60mm were used as part of the instruction/evaluation. By the end of the exercise, the confidence of the Marines to employ the sight in various night scenarios had increased significantly. Overall, the 60mm mortar sight was well received, simple to use and increased capability to engage targets faster and with greater accuracy in low-light conditions.

DRACONE
FLEXIBLE
FUEL
BLADDER

In September 2016, the Marine Corps Forces Pacific (MARFORPAC) and U.S. Pacific Fleet (PACFLT) science advisors collaborated to find an innovative way to deliver bulk fluids from ship to shore. Using a flexible fuel bladder called a dracone, the team successfully transferred fresh water from the USNS JOHN GLENN (ESD-2) to an amphibious bulk liquids transfer system (ABLTS) waiting on the beach at Naval Air Base Coronado. The dracone fuel barge is a system of rubberized bladders used by U.S. Navy to collect oil spills from the water's surface. They come in sizes ranging from 21,000 to 247,000 gallons, and are designed to be deployed and towed by boats. The team wanted to investigate employing dracones as a fuel storage and delivery system for resupply of forces.

The September demonstration exercised the concept of operations necessary to use dracone for shipment of bulk liquids. A dracone was deployed from and filled by the USNS JOHN GLENN at sea. It was then towed to a pre-determined location offshore and connected to a supply line that led to the ABLTS bladders. Water was successfully transferred to the ABLTS bladders from the dracone using a hydraulically driven transfer pump. This operational concept can be used to support distributed operations of small units that require less quantities of fuel. Dracones can be easily stored and transported by aircraft when empty. Overall, the objectives of the demonstration were met and work is ongoing to further develop this kind of capability to deliver bulk fluids from ship to shore.



A partially filled Dracone being towed to the beach off the Coast of NAB Coronado.

EARTHEN ROAD AND RUNWAY
STABILIZATION SYSTEM (ERRS)



MV-22 Hovering Over an ERRS Landing Pad in Basa Air Base, Philippines in April 2016

The Marine Corps Forces Pacific (MARFORPAC) science advisor and air operations team installed two one-acre helicopter landing pads at a remote air base in the Philippines. The pads were constructed by Marines from the 172nd Marine Wing Support Squadron (MWSS) in 3 weeks' time by mixing a proprietary polymer solution with the existing soil. The two pads successfully demonstrated a soil hardening and stabilization capability that allows the construction of roads and aircraft operating surfaces in less time and fewer resources required versus traditional means. The pads have operated for over two years for rotorcraft operations and have logged over 100 landings by MV-22, H-60, UH-1 and CH-47 aircraft.



UH-1Y Huey coming in to land at Basa Airfield stirring up large ash cloud on approach from degraded runway

Impact: The Earthen Road and Runway System (ERRS) is an alternative to traditional construction techniques involving concrete. It creates a surface that can support aircraft operations, while reducing the logistics footprint. Concrete requires sand, gravel and cement. ERRS combines with the soil present at the site, substantially reducing the amount of base materials needed for construction.



Inspecting earthen crust around the edge of the earthen pads

At Basa, there are two earthen pads that were built as science and technology initiatives in BK15. The eight-inch-thick pads were created by clearing the brush and leveling the surface with earth-moving equipment. Then an



MWSS and 3d MARDIV Marines discuss the creation of the earthen pads during BK15 with MARFORPAC Deputy Science Advisor Franz Ravelo at Basa Airfield

epoxy binder and soil were mixed together, using the base soil as an aggregate to make each pad. After this mixing, the pads are rolled flat to create the necessary density for maximum strength.

Both pads are robust and able to support Harrier and F-35 vertical takeoff operations. They were not used last year because of confidence issues, but that changed this year. The pads were used considerably by MV-22, UH-1Y, AH-1 Cobra and C-130 aircraft.

The earthen pads show much promise as a science initiative. They could offer a new way to scale up to larger projects like runways, while cutting the overall time, materials and equipment needed to build them.



UH-1Y Huey landing on the earthen pads during BK16

ONR EW BATTLE MANAGEMENT
SYSTEM / NOMAD / NEMESIS TESTING
DURING RIMPAC 2016



Command Pacific Fleet Science Advisor led a group of Pacific Fleet (PACFLT) staff members aboard the USS Howard and USS Pinckney for tours and briefings on electronic warfare battle management (EWBM) testing being conducted during the RIMPAC/Trident Warrior exercises. This group included the CPF executive assistant for cyber (SES), the CPF networks and communications director and representatives of CPF Requirements and CPF Warfighting Analysis.

The EWBM installations had achieved noteworthy success on-route to Pearl Harbor. The ONR Nemesis Electronic Warfare

(EW) Netted Offboard Miniature Active Decoy (NOMAD), part of the larger NEMESIS Innovative Naval Prototype (INP), had its first at-sea launches from the USS PINCKNEY. The pneumatically launched EW platform achieved a 30-minute flight time, which was twice the expected duration, allowing NOMAD to keep up with the ship for more than eight nautical miles, including transit at 20 knots. Further launches and testing included examination of Electromagnetic Interference (EMI) issues. NOMAD is capable of flying either as a single platform or in teams of multiple decoys to provide unmanned EW capabilities. This is a major technology maturation step forward for the NEMESIS INP.

EWBM achieved significant milestones toward the Chief of Naval Research’s netted sensors

and Surface Forces Command (SURFOR) distributed lethality initiatives. During RIMPAC, the USS Pinckney and USS Howard used EWBM during Anti-ship Cruise Missile (ASCM) engagement operations with ships from New Zealand, Australia and Canada, as well as networked tippers from Marines ashore during TAPA 16 exercise. EWBM provided a netted sensor picture to allow the participants to coordinate EW engagement with incoming missiles (represented by pods on Lear jets). EWBM also enabled the USS Pinckney to launch chaff



from the USS Howard, as well as control swarming unmanned aerial vehicle decoys. The EWBM project manager also provided a deep dive to members of the N9 staff and PACOM S&T and SCO representatives, and briefed Commander at Marine Headquarters.



HALF-SCALE UHAC DURING MUD
FLATS DEMO

The Marine Corps Forces Pacific (MARFORPAC) science advisor and ONR-sponsored NAVATEK LLC demonstrated a half-scale version of the Ultra Heavy-Lift Amphibious Connector (UHAC). The demo was at the Marine Corps Training Area Bellows (MCTAB) on the Island of Oahu in Hawaii. The UHAC is designed to be a low-

cost, high-volume, high-reliability ship-to-shore connector to enable amphibious logistical operations. It is a tracked vehicle that uses air foam cell treads for floatation and propulsion. It has demonstrated the capability to operate from an L-Class ship (LSD-47: USS Rushmore), transport a combat vehicle and logistic resupply loads,

and conduct amphibious beach landings and inland mobility. The MCTAB demonstration highlighted the UHAC’s ability to operate in an extremely challenging terrain of mud flats. The full-scale version of the UHAC is being designed to have a 200 nm range, travel at 20 knots in Sea State 3 and have a 130- ton payload.



Half Scale UHAC at MCTAB during the Mud Flats Demonstration in October 2015

ROBOTS WITH GUNS RIMPAC 16



One of the two largest armed UGV's that was employed during RIMPAC MIX 2016.



Large armed UGV's employed during RIMPAC MIX 2016.



UGV that was used to identify and lase targets reinforcing the village during RIMPAC MIX 2016. UGV designated laser guided 500 pound bombs dropped from Predator MQ-9B.

The Marine science advisors (I, II, III Marine Expeditionary Force (MEF), Marine Corps Forces Pacific (MARFORPAC), Marine Force Command (MARFORCOM) coordinated with the Marine Corps Warfighting Lab in support of RIMPAC 16 Marine Integrated Experiment at the Marine Corps Air Ground Combat Center, Twentynine Palms, California. The experiment was part of the Third Offset Strategy because science and technology are pushing the limits of human-and-machine teaming. Kilo Company 3d Battalion, 5th Marine Regiment participated in a movement and assault to an objective (a small village) while using suppressive fire from two machine gun teams and multiple unmanned ground vehicles. The Third Offset Strategy provides a force multiplier that allows robots to perform high-risk missions and improve situational awareness of the battlefield.



Marines and UGV's team together to provide suppressive machine gun fire. There are five fire team elements in the picture above; 2 Manned and 3 UGV's.



INTERNATIONAL ENGAGEMENTS

COLLECTIVE SENSING AND FLIGHT IN BAT SWARMS

As the Navy faces an increasing number of inexpensive yet serious threats, there is need to augment current defensive measures with groups of low-cost, autonomous systems that can seek and eliminate the threats effectively, while protecting warfighters from danger. One of the essential elements of naval science and technology strategy is the study and development of swarming autonomous systems, particularly, their command and control. Swarming autonomous systems should be able to accomplish thorough surveillance and assess the environment, detect and track targets, and maintain communication and coordination among elements of the swarm. In many engagements, autonomous swarms will have to perform these functions with little or no human supervision. The coordinated behavior of animal swarms in nature is recognized as a valuable source of inspiration and knowledge for the design of advanced autonomous swarms underwater, on the water's surface, on land and in the air. For example, the design of unmanned aerial vehicle (UAV) swarms can be inspired by the behavior of swarms of bats in pursuit of prey. ONRG met with an international bat expert at Tel Aviv University, Israel, and discussed the possibility of studying the complex behavior of bat swarms with accurate quantitative techniques. The discussions and initial estimates indicated the feasibility of measuring and recording the three-dimensional flight paths and echolocation sounds of numerous bats simultaneously. Bats produce echolocation calls to sense and track prey, communicate with other bats

and navigate in flight. ONRG and ONR funded Tel Aviv University to conduct a comprehensive study of the collective sensing and flight behavior of bat swarms outdoors and indoors. Outdoors, bats are instrumented with advanced, miniaturized GPS receivers that weigh only three grams, to record their flight paths with about one-meter accuracy. Indoors, a set of high-resolution cameras record flight paths with an accuracy of one millimeter. Recorded flight paths and echolocation sounds provide substantial and unprecedented information to analyze and model the collective activities of bats.

In this project, ONRG identified a world-renowned expert with unique experience and facilities, guided the formulation of a relevant research plan, articulated the potential benefits to ONR, implemented joint funding and launched a promising research effort to support a critical area of interest to the Navy. ONRG also discussed this project with the Israel Directorate of Defense Research and Development organization, which funds a complementary project at Tel Aviv University. The two projects enhance each other and contribute to the partnership between the U.S. and Israel.

NEW CATALYTIC MATERIALS FOR INNOVATIVE CATHODES IN MICROBIAL FUEL CELLS FOR LONG-TERM ENERGY PRODUCTION IN MARINE SYSTEMS

Naval International Cooperative Opportunities in Science and Technology Program (NICOP) Description: Ocean-based energy-recovery devices often harvest kinetic or solar energy. One emerging technology that could be implemented in ocean energy production is the microbial fuel cell. Currently, large rolls of carbon cloth or carbon fibers are used as cathodes in both sediment microbial fuel cell (SMFC) and roving microbial fuel cell (MFC) prototypes. The specific research goal of this project is decreasing the footprint of a cathode for both the SMFC and roving MFC by examining alternate cathode materials and designs. This research will focus on optimization of several conducting cathodic materials—which can facilitate the transport of bio-generated electrons, catalyze oxygen reduction and favor biological reactions to enable power to the MFC.

FISH-SKIN ACELLULAR DERMAL MATRIX (ADM) IN THE ACUTE CARE OF SEVERELY INJURED LIMBS

This grant focuses on developing the use of the fish skin as a temporary covering of extremity (foot) blast injury. Specifically, the skin will be used from the time of injury until the patient is in a full-service hospital. Blast injury with bone trauma is the focus here; for example, roadside bombs resulting in loss of extremities.

IMPACT: Wounded warfighter technology improvement for enhanced combat injury treatment and lifesaving. Research established a private company in Iceland in partnership with the Department of Defense medical community, which led to the U.S. Army grant referenced below.

Transition: The grant and the network associated with its development led to a US Army grant (<http://finance.yahoo.com/news/kerecis-receives-funding-dod-develop-163008388.html>) for:

- (i) Use as a temporary covering for burn wounds (i.e., immediately applied upon injury but removed when in full-service hospital) and for,
- (ii) Hospital use, after the wound has been cleaned and all dead flesh removed, for autograft sparring or as autograft substitution (e.g., replacement skin to act as a graft to replace cadaver skin and porcine (pig) surrogates).



KERECIS Combat Wound Dressing (artist rendering)

INDIA ENGAGEMENT

FY16 has been a productive year for active engagement with India, both in academia and military-to-military areas. Professor R. I. Sujith of the Indian Institute of Technology – Madras, Chennai, was awarded a research grant that enabled him and his graduate students to adapt methods of complex network analysis and nonlinear dynamical systems to predict precursors for instabilities. They developed an experimental set up to create instabilities in a combustion chamber modeling the combustion in jet engines. They successfully developed precursors describing the onset of aeroacoustics instabilities. This research is significant as it helps predict and avoid instabilities in engines, resulting in improved reliability. There also are wider applications, such as studying climate changes, ecosystems changes and biomedical prognostics. The results have been published in Nature and AIAA International Conference on Propulsion, and also presented to scientists at Naval Research Laboratory.

ONRG and the National Institute of Research & Development in Ship Building (NIRDESH), an autonomous body stood up by the India’s Ministry of Defense, Defense Production Department, collaborated to co-fund Dr. S. Gopalakrishnan, professor and chairperson, Department of Aerospace Engineering, at the Indian Institute of Science, Bengaluru. The research uses a novel numerical method, called spectral finite elements, and optimal smart materials to detect, isolate and mitigate structural acoustic vibrations in shipboard engine rooms. This is the first time a project is co-funded to an academic institution by India and

the U.S. on a topic benefitting both navies. The research aims to isolate and reduce noise, and potentially change the signature of future ships.

The increased interest in engaging India has been recognized by several visits from top leadership, including former President Barack Obama, Prime Minister Narendra Modi, Secretary of Defense Dr. Ashton Carter, Raksha Mantri, Mr. Manohar Parrikar, and Chief Navy Officer Admiral John Richardson. ONRG, under the instructions from the Chief of Naval Research Admiral David Hahn, has actively increased engagement with India and established an office there. The U.S. Department of State has approved ONRG’s request for an office in the centrally located city of Hyderabad. The Department of the Navy also has approved this office request and is awaiting final endorsement from the India’s Ministry of External Affairs. Having such an office will increase S&T engagement and collaboration, and sustain a strategic partnership with India.

Former Chief of Naval Research Rear Adm. Mathias Winter visited the Chief of Materiel VADM A.V. Subedhar to discuss topics of mutual interest for both navies. Other important visits by senior leadership included Executive Director Dr. Walter Jones, CO-ONRG CAPT Clark Troyer and Technical Director Dr. Patricia Gruber meeting with VADM Subedhar and Dr. S. Guruprasad at Defense Research & Development Organization (DRDO), discussing Indo-US collaboration in S&T areas of interest to both countries.

Other current research projects encompass corrosion-resistant coatings, blast mitigation of

marine composite structures, photovoltaic cells, stress corrosion, and blast mitigation of traumatic brain injuries. ONRG also supported international workshops, symposiums and conferences in gas turbines, corrosion control, nonlinear dynamical systems and self-similar structures, quantum computing, non-destructive testing in aerospace, sustainable and efficient propulsion technologies, and other areas aligned with naval S&T Strategy and Navy Research Enterprise interests.

A NEW PARTNERSHIP FOR AN AUV TOWED ARRAY

A new partnership between Dr. Y. T. Lin of Woods Hole Oceanographic Institution (WHOI), and Dr. V. Pallayil of the Acoustics Research was made possible by a Visiting Scientists Program (VSP) grant from ONRG, which also allowed Dr. Pallayil to travel to the Sediment Acoustics Experiment Planning meeting. Dr. Pallayil has the world’s thinnest towed array, suitable for an AUV. After some discussions at the planning meeting, Dr. Lin agreed to tow it behind one of WHOI’s AUVs in the upcoming Sediment Characterization Experiment, sponsored by Code 32. An AUV with a lightweight, thin towed array has many possible applications.

SUCCESS STORIES

- **Oxford University** Professor Henry Snaith successfully achieved greater than 20-percent efficiency with his perovskite-based solar cell, designed a multijunction solar cell with a goal of over30-percent efficiency (exceeding silicon) and demonstrated a 3,000-hour functioning life.
- **Cambridge University** Professor Vikram Deshpande developed a model to explain why the creep rate of high-temperature superalloys increases with time. Through a collaboration with General Electric (funded by Dave Shifler, Code 332), he validated the model and predicted creep response versus time and load against data from four GE-developed alloys. There is now the ability to connect the superalloy micro-structure to performance. Work is being carried out with GE to help improve Ni superalloy micro-structures. This work will lead to improvement of turbine blade designs in Navy engines. The next step is to predict the effects of cyclic loading.
- Collaboration is being re-established between the ONR and the **Swedish Defence Research Agency**, FOI. FOI has successfully stabilized ammonium dinitramide, a new oxidizer, which has the potential to substantially increase underwater explosive bubble energy, but was impractical until now because of hygroscopicity and formulation issues. FOI has worked to solve these challenges and has submitted a proposal to be jointly funded to ONR 33 and AFRL to scale and demonstrate this capability. Proposal is in ONR (HQ) grants awaiting obligation and execution.
- **Cambridge University** Professor James Elliott has succeeded in growing millimeter-length carbon nanotubes, long enough from which to spin fibers. They have also built and commissioned a spinning/drawing tower, and have succeeded in spinning fibers with a measured tensile strength of 1.2 GPa. Potential application is in advanced ballistic armor. Theoretical strength is greater than 50 GPa, so there is room for significant enhancements.
- A working group meeting was organized and held between ONRG, ONR35, DTRA and DSTL to discuss a potential collaboration in the development of reactive material-based warheads. The DSTL representatives have consulted with their management and are requesting funding to do a cost/payoff study for reactive material-based munitions.
- **Cambridge University** Professor Howard Stone is conducting research at part of a Rolls Royce/ EPSRC (UK Engineering, Physical Sciences, Research Council)-funded consortium on next-generation, high-strength/toughness materials capable of operating in high-temperature environments. ONRG provided support to a workshop on “Beyond Nickel Superalloys.” The meeting was attended by Dr. David Shifler, Code 332, who submitted a Multidisciplinary University Research Initiative topic in this area.
- ONRG hosted a visit by Dr. Joost van Lingen of Netherlands TNO, and held a VTC with Code 35, Code 33, **Naval Surface Warfare Center Indian Head, Research Development & Engineering Command Atlantic, European**

Office of Aerospace Research and Development and the Army Research Lab to discuss potential collaboration between TNO (Netherlands Organization for Applied Scientific Research), ONR and other services. TNO has submitted a white paper for review by ONR 35 on potential specific topics.

- Gulf of Tonkin Circulation Study, NICOP N62909-15-1-2018. Vietnamese scientists (supported by ONRG) and U.S. scientists (supported by Dr. Scott Harper of ONR Code 32) from **Scripps Institution of Oceanography UCSD, Oregon State University and Rutgers University** participated the Gulf of Tonkin Circulation Study Workshop, hosted by Center For Oceanography (CFO) of Vietnam Administration for Sea and Islands (VASI). They shared experimentation and simulation data to support the S&T focus areas, “Assure Access to the Maritime Battlespace.”
- The ONR Global Science Advisor to U.S. Pacific Command (PACOM) toured the east coast of the United States to raise awareness of command requirements. Sites visited included the Massachusetts Institute of Technology’s Lincoln Laboratory, the Air Force Research Laboratory, the Office of the Deputy Secretary of Defense for Emerging Capability and Prototyping, Johns Hopkins University Applied Physics Laboratory, the Defense Threat Reduction Agency, the Defense Technical Information Center, the Naval Research laboratory and ONR. These meetings resulted in several projects being funded to address key PACOM requirements.

SUCCESS STORIES [CONT..]

- The ONR Global science advisor to PACOM briefed several key leaders at ONR as part of the **Fleet Forces Forum**. This meeting increased the awareness of ONR’s contribution to the joint warfighters’ requirements in the Pacific area of responsibility.
- The ONR Global science advisor to PACOM participated in a series of meetings as part of the **Coalition Warfare Program (CWP)** to raise awareness of U.S. Combatant Command requirements within the coalition community. This meeting resulted in two coalition projects being identified and funded.
- The ONR Global science advisor to PACOM represented PACOM and all the combatant commands at the **Reliance 21 Communities of Interest (COI)** meeting in Washington, D.C. This event raised awareness of COCOM requirements and the role of COCOMs in the service requirements process.
- The ONR Global science advisor to PACOM accompanied the Undersecretary of Defense for **Acquisition, Technology and Logistics (USD AT&L)** on a tour through the Pacific area of responsibility. This tour raised the Secretary’s awareness and understanding of PACOM’s unique requirements. PACOM manages \$233 million in projects for USD AT&L.
- The ONR Global science advisor to PACOM represented PACOM and the geographic combatant commands at the annual Department of Defense S&T Strategic Overview. This event is a central element of the process for ensuring S&T alignment with DoD strategic direction and priorities.
- The ONR Global science advisor to PACOM visited **Aerospace Data Facility-Colorado (ADF-C) and Air Force Tactical Exploitation of National Capabilities (AF TENCAP)** to brief leadership on command requirements, and identify areas where ADF-C and PACOM can improve collaboration. The meeting resulted in a coalition project with Australia with \$40M leveraging an Australia system worth \$18B.
- The ONR Global science advisor to PACOM hosted the **Pacific Operational Science and Technology (POST)** Conference. This conference focused on bringing together military, government civilian, industry and academic leaders from across the PACOM theater to discuss enhancing situational awareness through science and technology from a coalition perspective. The conference drew over 600 people, including active-duty and retired four-star combatant commanders.
- The ONR Global Science Advisor to PACOM represented the command at a US/India meeting to identify S&T projects of interest to both countries.
- The ONR Global science advisor to PACOM joined the chief of naval research on his visit to India to establish an ONR science director position in India. The visit included briefs to the U.S. Ambassador to India and resulted in the request being expedited.
- In collaboration with ONR 33, Dr. Ming-Jen Pan built a network of key international researchers of piezoelectric single crystal, the next-generation sonar material that has exceptional properties and is of great importance to the U.S. Navy. The partnership (Naval International Cooperative

Opportunities in Science and Technology, Collaborative Science Program, and Visiting Scientists Program) includes scientists in Japan, Korea, Australia and United Kingdom. Efforts to deepen S&T exchange with UK Defence S&T Laboratory (Dstl) and Australia Defence S&T Group (DSTG) under The Technical Cooperation Program framework is ongoing. The engagement will facilitate the adoption of this new class of material into future sonar systems.

- Researchers at the **Pontifcate University of São Paulo**, supported with ONRG funding, have started co-publishing their research with the Naval Research Laboratory. The work focuses on orientation control of gold nanorods, which offers novel opportunities for micro-sensor design, whether on Navy ships or at the bottom of the ocean. With the provision of a Naval International Cooperative Opportunities in Science and Technology, the collaborating parties are now able to leverage their respective government investments to the benefit of objectives that support the U.S. Navy.
- ONRG funded the **University of Ghana** to collaborate with the **University of Maryland** on DARPA’s Low Resource Languages for Emerging Incidents (LORELEI) program. The program aims to develop translation tools that can work for languages too rare to be supported by databases. Using NICOP funding, the university sent a graduate student, who is a native speaker of several African languages, to provide critical assistance in language expertise. This support will

help ensure the production of a quality system to be used by Navy forces during humanitarian assistance crises.

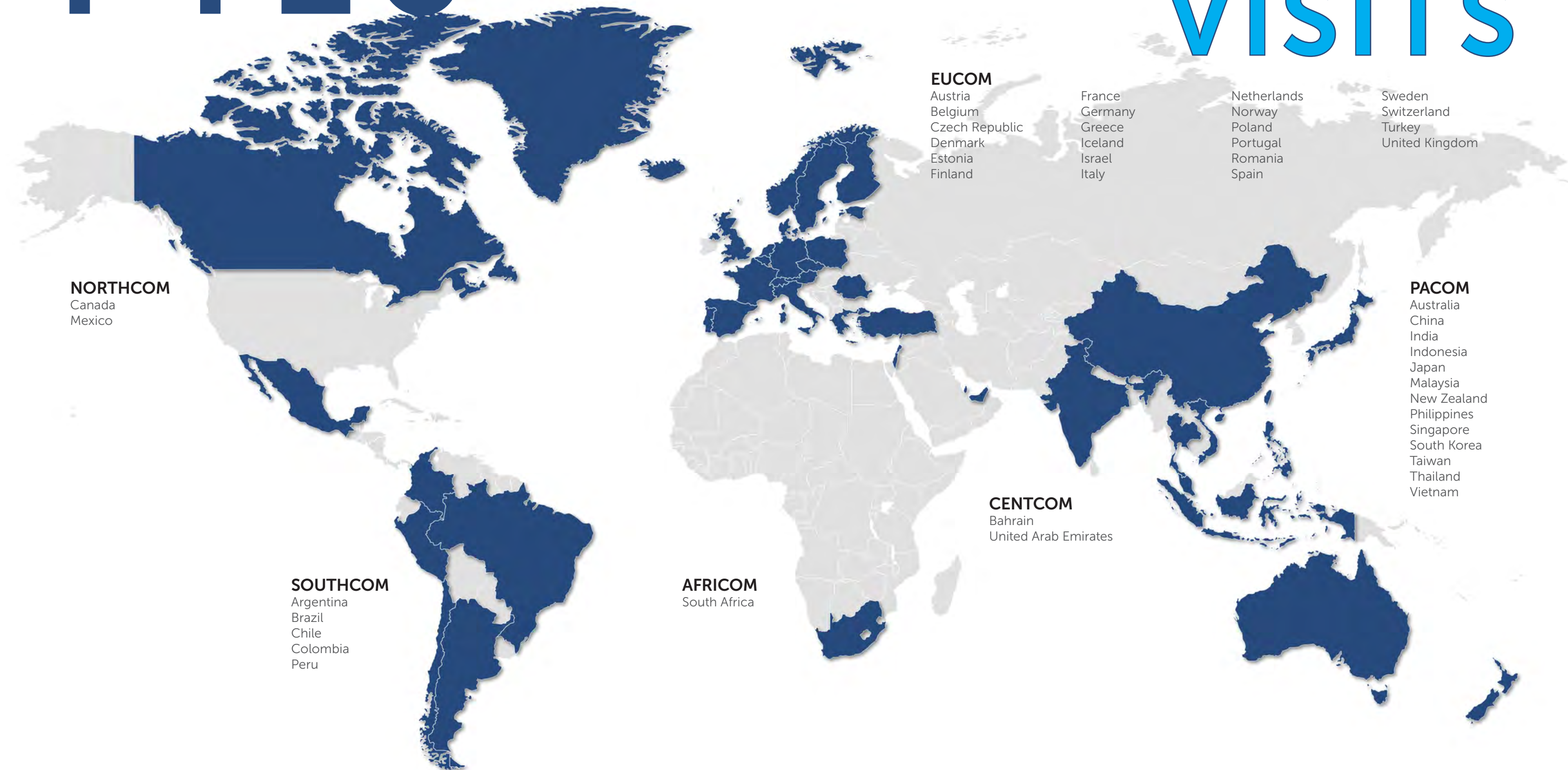
- ONRG visited the **University of Buenos Aires** with the National Oceanic and Atmospheric Administration (NOAA) to develop a project supported by both the government of Argentina and the research community. Argentine scientists designed an effort focusing on ocean turbulence at the edge of the Argentine shelf, in collaboration with scientists from the University of Miami. The effort is developing a foundation of trust between the Argentine government and research communities, so that ONRG can collaborate more broadly with Argentine projects of interest to the U.S. Navy.
- ONRG worked with the **Naval International Programs Office** to help shepherd a bilateral Research, Development, Technology, and Engineering (RDT&E) agreement with the Republic of South Africa. The team had been collaborating with the Naval Research Laboratory and SPAWAR Systems Center Pacific to develop an initial collaborative Navy program, pending signature. This effort will focus on data exfiltration and analysis for Maritime Domain Awareness. The U.S. Navy will benefit from the experience of South African defense researchers working in isolated marine environments, where piracy and other illegal activities are more likely to occur.
- In an effort to effectively match staffing with grant production, the U.S. ambassador to Brazil was engaged to discuss expansion of the ONRG São Paulo office. Since approval, the

group has grown to two science directors and a locally hired office manager. The U.S. Army’s Research, Development, and Engineering Command also took advantage of ONRG’s presence to add a representative. The office can now better engage the region, given Brazil’s position as the top producer of research in Latin America.

- ONRG Santiago hosted a **“Celebration of Science”** event in May 2016, which broadened awareness of our science grants programs, discussed the importance of science in a knowledge economy, and spotlighted the bright ideas and breakthrough research emerging from Chile. ONRG hosted more than 150 top scientists, researchers and Chilean Government representatives at the U.S. ambassador’s residence and has received positive responses from the event and direct proposals submitted to our grants programs.

FY16

LIASON VISITS





**CHIEF OF NAVAL
RESEARCH AND
EXECUTIVE
DIRECTOR
INTERNATIONAL
ENGAGEMENTS**

INTERNATIONAL COOPERATION ENGAGEMENT PROGRAM FOR POLAR RESEARCH (ICE-PPR)

For the first time in nearly 60 years, since the establishment of The Technical Cooperation Program (TTCP) in 1957, a new multinational defense research, development, test and evaluation (RDT&E) framework for cooperation is being established. Dubbed the International Cooperative Engagement Program for Polar Research (ICE-PPR), defense officials and scientists from partner nations with Arctic and Antarctic interests—including Canada, Denmark, Finland, Iceland, New Zealand, Norway,

Sweden and the United States—are seeking to advance collaboration on polar research that could prove pivotal to not only scientific understandings, but also U.S. and international naval operations. To address the need for collaborative research in the Polar Regions, former Chief of Naval Research Rear Adm. Mat Winter met in Helsinki, Finland, in February 2016 with counterparts from five nations in a first-ever gathering of senior defense officials to coordinate science

and technology research in high latitudes. While the U.S. Navy has long experience with polar operations, changing climates present new challenges—particularly for surface ships—as new water passages open up. “Cooperative polar research is essential to ensuring safe maritime operations in these rapidly changing regions,” said Winter. “ICE-PPR will allow the U.S. Navy and our partners to outline and coordinate our respective needs and priorities moving forward.

The longstanding research and operational experience of our polar partners will play a key role in advancing U.S. knowledge and capabilities in these extremely challenging regions of the world.”

The meeting answered the recent call from Chief of Naval Operations Adm. John Richardson to rapidly accelerate learning and provide new capabilities to the fleet. The Design for Maintaining Maritime Superiority specifically calls for expanding and strengthening the Navy and Marine Corps network of partners—including a directive to “prioritize key international partnerships through information sharing, interoperability initiatives and combined operations.”

Ongoing research sponsored by the Office of Naval Research (ONR) is increasing the world’s understanding of the changing environment in the Arctic, documenting a steady reduction in summer sea ice, with the resultant opening up of previously inaccessible waterways for extended periods of time each year.

At the gathering, representatives from each nation presented an overview of ongoing polar research activities, and outlined their top research priorities that could benefit from increased international science and technology collaboration.

Officials say the research collaboration will run the gamut from long-term fundamental research partnerships to applied research and even system prototypes—enabling more immediate opportunities to provide new technologies and

capabilities to the fleet, a CNO priority. The results could enhance capability for the Navy to support the U.S. Coast Guard in search and rescue operations, as well as the ability to more swiftly provide humanitarian and disaster relief around the world.

Long-term U.S. priorities discussed at the gathering included the enhancement of polar platforms, including surface ships and autonomous vehicles; the improvement of remote sensing in Polar Regions; and the exploration of how to enhance human performance in some of the most physically challenging regions of the world.

The CNR, Dr. Walter Jones and senior national representatives met again on October 4-6, 2016, in Yellowknife, Canada, at Joint Task Force North headquarters, to discuss the future of scientific research and naval operations in the Arctic.

The main purpose of the second meeting was to get countries with an interest in cold-weather operations around the table to identify priorities and align their defense to ensure the greatest impact on participating nations’ security. The meeting included discussion of the formal agreement among participating nations, and identifying specific activities to be contributed by each nation.

“The enthusiasm and energy shown by all participants to work together to tackle tough polar science and technology problems was absolutely incredible,” said Dale Reding, director, General Science and Technology Air and Navy for Defense Research

and Development Canada. “Bringing together like-minded polar nations, under the ICE-PPR banner, has already led to an explosion of innovative ideas on how to better enable naval operations in polar environments.”

“The mutual sharing of science and technology will be essential, both short-term and long-term, to the U.S. Navy and Marine Corps, to the Department of Defense and to our international partners,” said Winter.



Dale Reding (left), Frank Herr, Walter Jones, RAdm John Newton, and BGen Mike Nixon discuss Canadian operations in the Arctic Circle during the second International Cooperative Engagement Program for Polar Research held in Yellowknife, Northwest Territories.

INTERNATIONAL CNRS PANEL AT SEA-AIR-SPACE 2016 (MAY 2016)

For the first time ever, a panel of chiefs of naval research from Australia, Brazil, Canada, Colombia, Singapore, the United Kingdom and the United States was convened at the Sea-Air-Space Expo in May 2016. Cyber and electronic warfare, shrinking defense budgets, and critical international science and technology partnerships were some of the key concerns for the seven military leaders who met in National Harbor, Maryland.

Sharing thoughts about present and future fleet and force needs during the “International Naval Leadership Panel: Naval Technology 2025 and Beyond,” the chiefs of naval research talked about common technology challenges—and opportunities—in a session moderated by former U.S. Chief of Naval Research (CNR) Rear Adm. Mat Winter.

“As we look at a global proliferation of threats, how can we stay ahead?” said Winter, who served as CNR from 2014 to 2016.

The consensus answer from the panelists was that science and technology (S&T) collaborations will be essential to giving warfighters the edge in a rapidly changing and technologically advancing world.

“International partnerships are literally a force multiplier,” said Winter. “No one place has a monopoly on innovation or new concepts.”

The regular exchange of scientists and engineers between partner nations was also emphasized, reflecting a strong desire for interoperability, which in turn contributes to making research more cost effective and mutually beneficial, and increases mutual reliance.

The annual Sea-Air-Space Expo is hosted by the Navy League and focuses on matters of interest to the U.S. Navy and Marine Corps.

Multiple technologies were listed by the participants as key to future maritime security. Common areas

of concern, and opportunity, that were central to the assembled naval S&T leaders included:

- Staying ahead of adversaries in the rapidly changing cyber arena.
- New research to enhance human performance. For example, both Winter and Rear Adm. Harris Chan of Singapore discussed cutting-edge research projects designed to provide individuals with seemingly superhero-like healing and load-carrying capabilities.
- Developing advanced autonomous unmanned platforms for use beneath the waves, on the surface and in the air.

To achieve and maintain dominance in different critical research areas, officials said, international partnerships have been, and will be, increasingly essential. Each country has its own industry and academia capable of providing unique perspectives and experiences. Collaboration advances new capabilities for the future force through diverse approaches and shared resources, with costs reduced by leveraging related work and avoiding duplication of research.

This important commitment, said Winter, has already proved its value, and will continue “to ensure our warfighters have the technological advantage to achieve their mission.”



CHIEF OF NAVAL RESEARCH AND EXECUTIVE DIRECTOR INTERNATIONAL ENGAGEMENTS IN FY16



RADM Winter and group on board HMNZS Otago. L-R, Shala Malone (N84), CAPT Blair Gerristen (Director, Futures Directorate - RNZN), CNR, LCDR (CO of HMNZS Otago), CDR Blake McBride (ONRG), Loc Nguyen (ONRG)

Austria	France	Norway
Australia	Germany	Peru
Belgium	Iceland	Portugal
Brazil	India	Singapore
Canada	Israel	South Africa
Chile	Italy	South Korea
Colombia	Japan	Sweden
Denmark	NATO	Turkey
Estonia	Netherlands	United Kingdom
Finland	New Zealand	Vietnam



While visiting the U.S. Embassy in Tokyo, Japan to discuss science and technology partnerships between the U.S. and Japan, representatives from the DoN, ONR and ONR Global pose with the official seal of the DoN's Office of the General Counsel to help celebrate the office's 75th anniversary this year. Back row (from left): Bob Cuff, Navy International Programs Office (NIPO); Shala Malone, Senior National Representative; Dr. Chris Bassler, ONR Global, CDR Scott Rose, ONR Global; and Mark Buffum, ONR Global. Front row (from left): Lt. Col. Steven Browne, Mutual Defense Assistance Office, U.S. Embassy, Tokyo, Japan; ONR Global; and Chief of Naval Research Rear Adm. Mat Winter. (Photo courtesy of Lt. Marten Coulter)

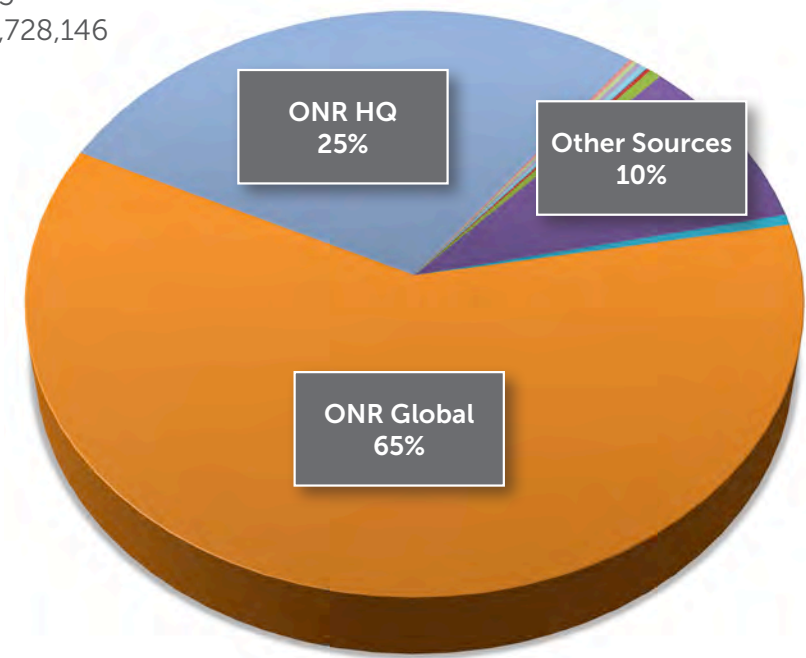


GRANTS EXECUTION AND DISTRIBUTION

FY16 GRANT EXECUTION

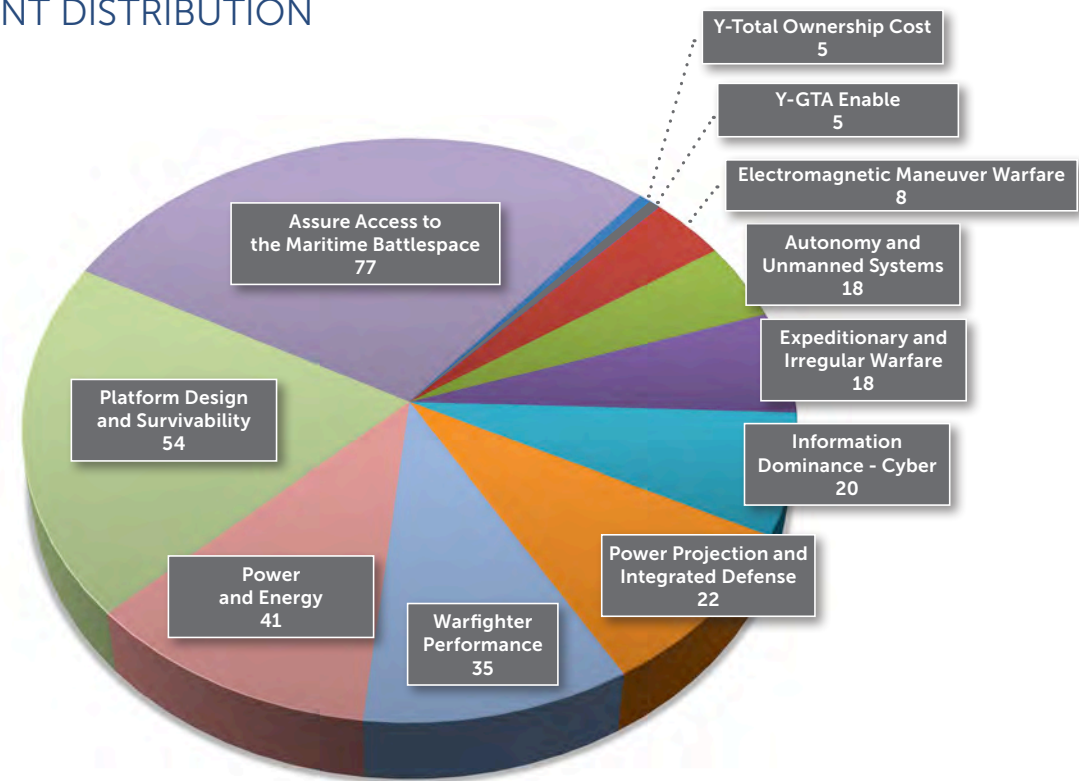
FY16 GRANT FUNDING

FY16 Total Grants: 303
FY16 Grant Total: \$14,728,146



FY 16 INTERNATIONAL SCIENCE PROGRAM GRANT DISTRIBUTION BY S&T FOCUS

Total Grants - 303



FY16 INTERNATIONAL SCIENCE PROGRAM GRANT DISTRIBUTION

303 GRANTS ACROSS 52 COUNTRIES





STAFF AWARDS

STAFF AWARDS



Robert Bolia
Science Director of the
Year awarded 9 June 16



Kathleen Dooley
Length of Service Award
(25 years) awarded
25 February 16



Yoko Furukawa
Navy Meritorious Civilian
Service Award awarded
during GTM



Tanya Gogue
Navy Meritorious Civilian
Service Award awarded
during GTM



Charles Holland
Navy Meritorious Public
Service Award awarded
25 May 16



John Morrison
Navy Meritorious Civilian
Service Award awarded
during GTM



Loc Nguyen
Navy Meritorious Civilian
Service Award



Matthew Poe
Navy Superior Civilian
Service Award



Liming Salvino
Navy Meritorious Civilian
Service Award awarded
29 June 16



Satish Skariah
Meritorious Service Medal
awarded 8 July 16



Steven Smolinski
Navy Superior Civilian
Service Award awarded
8 June 16



Ryan Zelnio
Navy Meritorious Civilian
Service Award



Global Technical Meeting
September 2016





CONTACT US

onrg.contactus@mail.mil

www.onr.navy.mil/global